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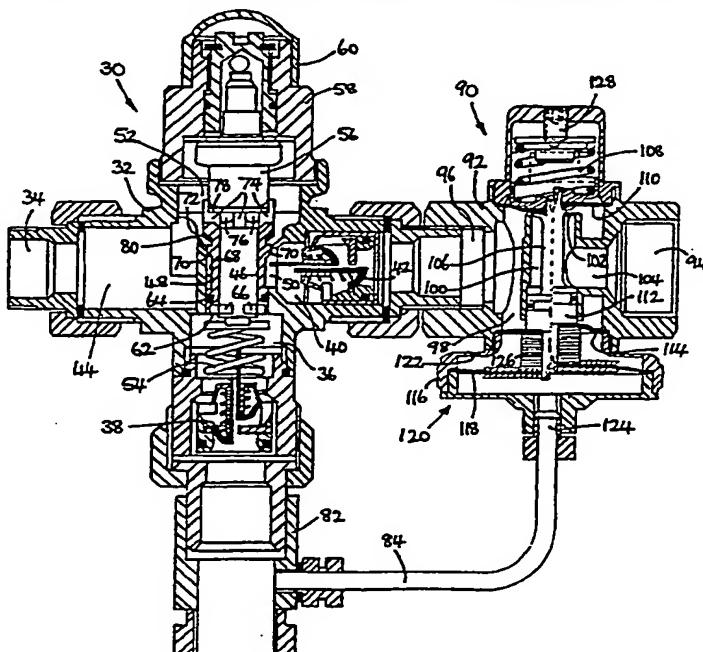
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## (54) Flow control for mixing valves

(57) A thermostatic hot and cold water mixing valve (30) is close coupled to a flow control valve (90) in the hot water supply. In the flow control valve, spring (108) biases valve spool (106) to a closed position, but cold water supply pressure transmitted by pipe (84) from the cold water inlet side of the mixing valve (30) operates actuator (120) to oppose the spring and keep the hot water supply open so long as cold water pressure is maintained. If cold water pressure fails, the hot water supply is immediately shut off.



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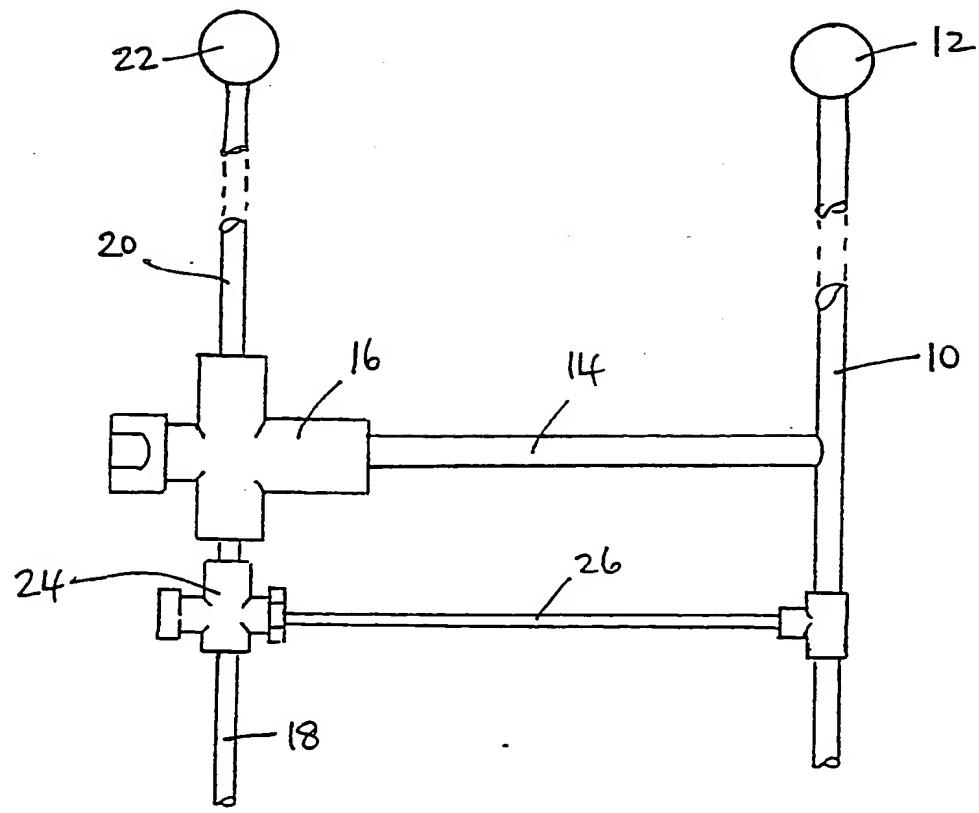


Fig. 1

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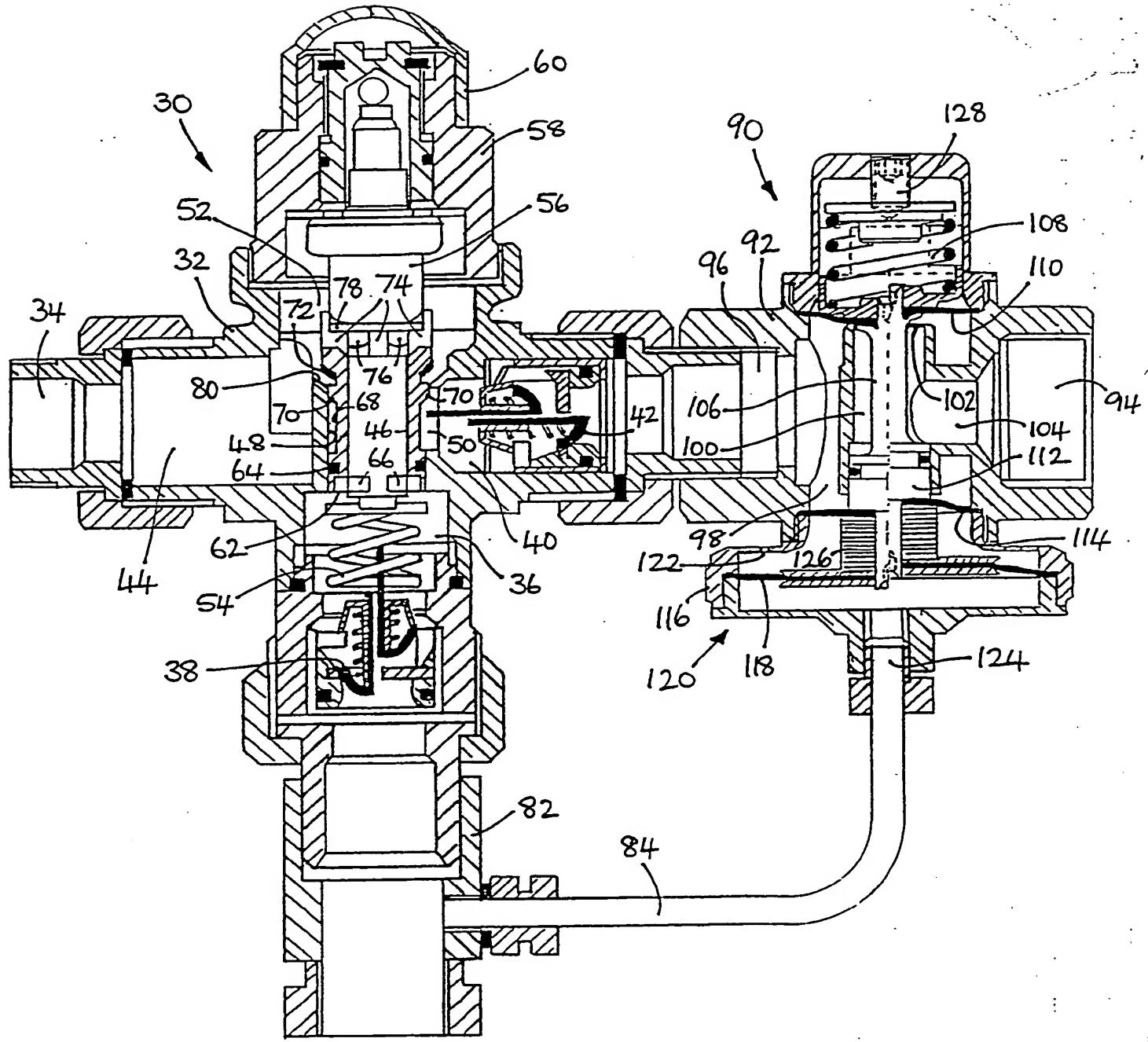


Fig.2

FLOW CONTROL FOR MIXING VALVES

This invention relates to flow control for mixing valves, and especially for thermostatic mixers.

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Thermostatic mixing valves are used in many applications. One application of particular interest is mixing hot and cold water for supply to handwash basins to reduce hot tap temperatures. This is particularly important in hospitals, schools, homes for the elderly and infirm, sports centres, factories, prisons and the like, to ensure that the normal hot water temperatures of about 60°C do not cause scalding. Besides hand basins, mixing valves of this kind can be used in sinks, baths, bidets, showers, hair wash sprays, small washing machines, combination boilers, photographic processing and industrial washdown.

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In existing valves for mixing hot and cold water supplies, a thermostatic element may be provided to maintain the outlet temperature, and to close the valve entirely if the cold water supply fails. This is clearly a desirable safety measure in certain circumstances. However, it is very difficult to increase the speed of response beyond a certain point.

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It would be possible to use electrically driven valves to provide a rapid shut off of hot water, but this imports another technology, with the need for a power supply and additional safety precautions. It is an object of the present invention to provide a mixing valve with an improved response time, without the need for any external power source.

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According to the present invention, a hot and cold water mixing valve is provided with a flow control valve responsive to water pressure in the cold water supply to the mixing valve, the flow control valve being adapted to prevent hot water being delivered through the mixing valve upon reduction in the cold water pressure

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below a threshold value. The flow control valve may include a valve member movable between open and closed positions in the hot water path, which valve member is constantly urged towards the closed position by biasing means, while being movable against the

5 biasing means into the open position by a cold water pressure above a threshold value, whereby the biasing means immediately returns the valve member to the closed position when the cold water pressure falls below that value.

10 The mixing valve is preferably a thermostatic mixing valve.

The flow control valve may be either upstream or downstream of the mixing valve. If upstream, it will be in the hot water inlet line, and if downstream, it will be in the mixed hot and cold water

15 outlet line.

The invention, as summarised above, involves two inlets and one outlet to the mixing valve, but it will be clear that the invention also applies, in a similar way, to other mixing valve arrangements.

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The flow control valve can be integrated with the mixing valve, so that both functions are present in a single unit, or can be provided separately upstream or downstream of the mixing valve.

25 The flow control valve preferably comprises a fluid actuator for the valve member, operated by cold water pressure. The actuator may be of the diaphragm, piston or bellows kind. Simple biasing means for the valve member are springs, including elastic bodies of various kinds. Typically, a spring urges the valve member into its

30 closed position, but provided that the cold water pressure is sufficiently high, the actuator is capable of overcoming the spring force and holds the valve member in the open position against the spring.

35 The flow control valve has hot or mixed hot and cold water flowing through it while it is open, and the hydrostatic and hydrodynamic

pressure effects of this water are capable of affecting the balance  
of the valve. The effective surface area of those parts of the  
actuator that are responsive to cold water pressure, normally the  
projection of these surfaces in a plane perpendicular to the motion  
5 of the actuator, should be sufficiently large that any opposing  
force on the actuator due to internal pressure in the valve is  
insignificant in comparison with the force on the actuator derived  
from the cold water pressure. This increases the sensitivity of  
the flow control means to variations in cold water pressure.

10 Preferably the flow control valve comprises a valve body containing  
a valve chamber, an inlet duct which is open to the valve chamber,  
an outlet duct communicating with the valve chamber through a valve  
chamber outlet, and a cold water inlet; the valve chamber contains  
15 a valve member in the form of a spool movable between a first  
position in which the valve chamber outlet is closed to the outlet  
duct and a second position in which the valve chamber outlet is  
open to the outlet duct; biasing means constantly urges the spool  
towards the first position; and pressure at the cold water inlet is  
20 transmitted to the spool to hold it in the second position against  
the biasing means for so long as the cold water pressure exceeds a  
given threshold value.

25 The cold water inlet may lead to an actuator for the spool,  
preferably diaphragm means, having a large effective area exposed  
to the cold water pressure and a smaller effective area exposed to  
the pressure of water flowing through the flow control means.

30 The invention is illustrated, by way of example only, in the  
accompanying drawings, in which:

Fig 1 illustrates one possible arrangement of flow control valve and thermostatic mixing valve connected to hot and cold water supply pipes and cold and mixed water outlet pipes; and

5 Fig 2 is a sectional view of one embodiment of a close coupled thermostatic mixing valve and flow control valve in accordance with the invention.

10 In Fig 2, certain internal components of the respective valves are depicted simultaneously in a first position on one side and in a second position on the opposite side of the same component. This is purely for the purpose of illustrating the two extreme positions of these components in a single drawing. In actuality, each of these components is of course wholly in one position at any given  
15 moment.

Fig 1 shows a cold water supply pipe 10 which leads to a cold tap 12. A branch pipe 14 takes a cold water supply to a thermostatic mixing valve 16, which also receives a hot water supply in pipe 18.  
20 A delivery pipe 20 from the thermostatic mixing valve takes a temperature stabilised hot water supply to a hot tap 22.

As so far described, this is a conventional arrangement. Water for domestic use is desirably stored at 60°C to reduce the risk of  
25 contamination by bacteria, but the temperature is reduced by mixing with cold water before delivery to the user, to reduce the risk of accidental scalding and to save energy by limiting wasteful use of hot water. The temperature may be reduced to as little as 35°C, but an ideal is considered to be 43°C.

30 A thermostatic element in the mixing valve 16 will move a flow dividing piston to maintain the desired outlet temperature, but if the cold water supply fails entirely there will be a perceptible time delay before the hot water supply pipe is closed off, and  
35 during this time water at a potentially scalding temperature would be delivered through the hot tap 22.

To prevent this happening, and in accordance with the present invention, flow control valve 24 is installed in the hot water supply pipe 18 upstream of the thermostatic mixing valve 16. The flow control valve is kept open by cold water pressure transmitted through relatively small bore supply pipe 26 from cold water supply pipe 10. If the cold water pressure falls below a predetermined threshold value, valve 24 immediately closes and prevents hot water from flowing to the mixing valve.

5 10 Fig 2 shows a close coupled thermostatic mixing valve 30 and flow control valve 90, in accordance with the invention, in more detail.

15 Mixing valve 30 comprises a brass valve body 32 for delivering mixed hot and cold water to delivery pipe 34. The valve body has a cold water inlet 36, to which is fitted a polypropylene check valve 38, a hot water inlet 40, to which is fitted a polypropylene check valve 42, and a mixed water outlet 44. The check valves (non-return valves) 38 and 42 are shown split, each with one half in the open position and one half in the closed position, solely 20 for the purpose of illustration, and of course each valve is in fact wholly in one position when in use.

25 A tubular polypropylene flow dividing piston 46 is located in a cylindrical bore 48 which is central in the mixing valve body 32, and coaxial with the cold water inlet 36, which communicates with one end of the bore 48. The opposite end of the bore opens into chamber 52, which is in turn open to mixed water outlet 44. Hot water inlet 40 communicates with opening 50 in one side of bore 48, between the two ends of piston 46.

30 Piston 46 is held in position between spring 54, located in the cold water inlet 36 at one end of the bore 48, and copper/wax thermostatic element 56, which is held in chamber 52 by a cover 58. A tamper-proof top cap 60 is provided to prevent unauthorised 35 adjustment of the valve.

Hollow tubular mixing valve piston 46 has a piston head 62 at the cold water inlet end of bore 48, slideably sealed in the bore by O ring 64. Between the closed end of the piston head and the O ring, four circumferentially spaced inlet ports 66 admit cold water to the interior of the piston. Above the piston head is a waist 68, opposite wall opening 50. Around the upper end of the piston waist are spaced four support flanges 70, which keep the piston axially aligned within bore 48. The upper end of the piston is open and projects into chamber 52, where it terminates in four circumferentially spaced arms 74, which carry a disc 78 which bears against thermostatic element 56. The spaces between the arms 74 define four cold water outflow passages 76 from the interior of the piston into thermostat chamber 52.

The opening of bore 48 into chamber 52 is formed with a conical valve seat 80, and the piston is provided with a corresponding conical sealing ring 72 between the flanges 70 and the arms 74. The mixing valve 30 is illustrated in the hot water fully open and cold water fully closed position, in which hot water from inlet 40 can flow through opening 50 into bore 48, where it surrounds the piston waist 68 and flows upward past flanges 70 and out of the bore between valve seat 80 and sealing ring 72 into thermostat chamber 52. As the thermostat element 56 warms up and expands, piston 46 is moved down the bore against spring 54, progressively closing the sealing ring 72 on to the valve seat 80, thereby diminishing hot water flow, and at the same time exposing piston head inlet ports 66 to the cold water inlet 36, thereby permitting cold water to flow through the piston into thermostat chamber 52, where it mixes with the hot water. The mixed hot and cold water leaves through outlet 44.

It can readily be seen that a correctly set thermostat element 56 will stabilise the outlet water temperature. As the mixed water temperature varies from the ideal, the thermostatic element expands or contracts and thereby adjusts the position of the mixing valve piston 46, to regulate the relative proportions of hot and cold

water and restore the ideal temperature. However, the response time is dependent on the rate of heat transfer to the element from the water in chamber 52. If the cold water supply were to fail, a perceptible time would elapse during which hot water only would 5 flow through the mixing valve, before the expanding element could close sealing ring 72 against valve seat 80.

In accordance with the invention, a flow control valve 90 is provided to shut off the hot water flow as soon as the cold water 10 pressure drops below a certain value. Cold water pressure is sensed by providing a branch pipe connector 82 upstream of mixing valve cold water inlet 36, from which a small bore pipe 84 leads cold water at supply pressure to the flow control valve 90.

15 The internal parts of flow control valve are shown split between open and closed positions, for illustrative purposes only.

The flow control valve 90 is a fail safe shut off valve having a 20 valve body 92 containing an inlet duct 94 aligned with an outlet duct 96, and between them an intermediate chamber 98 opening to the outlet duct. Within the intermediate chamber is a cylindrical 25 valve chamber 100, disposed transversely to the inlet and outlet ducts. One end of the cylindrical valve chamber forms an outlet 102 communicating with the intermediate chamber, and a port 104 in the side wall of the valve chamber opens directly into the inlet duct 96.

Hot water can pass through the flow control valve from the inlet 30 duct 94 through port 104, valve chamber 100, valve chamber outlet 102, intermediate chamber 98, and outlet duct 96, which is directly connected to mixing valve hot water inlet 40.

The valve chamber contains a valve member in the form of a spool 35 106 movable between a first position (as shown in the left hand split) in which the valve chamber outlet 102 is closed to the outlet duct and a second position (as shown in the right hand

split) in which the valve chamber outlet is open to the outlet duct. The valve spool at one end passes through the outlet 102 into the intermediate chamber, where it is secured in the centre of a first small circular diaphragm 110, which closes this end of the intermediate chamber. On the other side of the diaphragm 110, biasing means in the form of spring 108 constantly urges the spool towards the first position, in which the outlet is closed by pressure of the diaphragm against it.

5      The opposite end of cylindrical valve chamber 100 is permanently closed by a piston 112 at the corresponding end of spool 106; however, the piston projects beyond the valve chamber into the intermediate chamber and is secured to a second small circular diaphragm 114, of the same diameter as the first small diaphragm 110, which closes this end of the intermediate chamber.

10     On the other side of the diaphragm 114 is an actuator 120, comprising casing 116 containing a large circular diaphragm 118, to the centre of which is rigidly connected an extension 126 of spool 106 beyond piston 112 and diaphragm 114. The volume between the two diaphragms varies if the spool moves axially in valve chamber 100, so air bleed hole 122 is provided in the casing 116 between the diaphragms.

15     Actuator 120 is provided with a cold water inlet 124 to which pipe 84 is connected, so that the outer face of diaphragm 118 is exposed to cold water pressure. This pressure at the cold water inlet is transmitted to the spool 106 as an axial force. If sufficient pressure is exerted by cold water pressure in the actuator, the force of spring 108 is overcome and spool 106 is moved against the force of the spring to the second position, in which valve chamber outlet 102 is opened, as illustrated in the right hand split in the drawing. The valve chamber outlet 102 will remain open, allowing hot water to flow, for so long as the cold water pressure exceeds a given threshold value.

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Actuator 120 has a large effective area (the area of diaphragm 118) exposed to the cold water pressure and a smaller effective area (the area of diaphragm 114) exposed to the pressure of water flowing through the flow control valve.

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The effective surface area of the large diaphragm 118 and the stiffness of spring 108 are chosen to give a suitable threshold value whereby hot water flow to mixing valve 30 can be immediately shut off if the pressure in cold water supply pipe 14 falls

10 dangerously low, allowing the force of spring 108 to overcome the force of the cold water pressure in the actuator 120 and move valve spool 106 from its open second position to its closed first position before the temperature can rise at the mixed water outlet of the mixing valve.

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When the flow control valve is closed, the pressure of hot water in the intermediate chamber 98 is equal on the two small end diaphragms 110 and 114, and the pressure of hot water in the valve chamber 100 is equal on the respective internal end faces of the spool 106. Since the two diaphragms, and the two end faces, have equal effective areas, there is no net axial force on the spool 106 arising from water pressure within the flow control valve.

20 However, when the cold water pressure is sufficient to open the valve, hot water flowing through the restricted outlet 102 and over the diaphragm 110 causes a local pressure drop, and the actual hydrodynamic and hydrostatic effects vary with hot water pressure and flow rates. The multiplier effect of the actuator helps to ensure that the system remains effective even when set for a low cold water threshold pressure and high hot water pressures and flows. As a further enhancement, adjuster screw 128 is provided to enable the loading of spring biasing means 108 to be varied.

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CLAIMS

- 1 A hot and cold water mixing valve provided with a flow control valve responsive to water pressure in the cold water supply to the mixing valve, the flow control valve being adapted to prevent hot water being delivered through the mixing valve upon reduction in the cold water pressure below a threshold value.
- 2 A hot and cold water mixing valve according to claim 1 wherein the flow control valve includes a valve member movable between open and closed positions in the hot water path, which valve member is constantly urged towards the closed position by biasing means, while being movable against the biasing means into the open position by a cold water pressure above a threshold value, and the biasing means is adapted to return the valve member to the closed position when the cold water pressure falls below that value.
- 3 A hot and cold water mixing valve according to claim 1 or claim 2 wherein the flow control valve comprises a fluid actuator for the valve member, which actuator is operable by cold water pressure above the said threshold value to move the valve member into the open position.
- 4 A hot and cold water mixing valve according to any one of the preceding claims wherein the flow control valve comprises a valve body containing a valve chamber, an inlet duct which is open to the valve chamber, an outlet duct communicating with the valve chamber through a valve chamber outlet, and a cold water inlet; the valve chamber contains a valve member in the form of a spool movable between a first position in which the valve chamber outlet is closed to the outlet duct and a second position in which the valve chamber outlet is open to the outlet duct; biasing means constantly urges the spool towards the first position; and cold water pressure

at the cold water inlet is transmitted to the spool to hold it in the second position against the biasing means for so long as the cold water pressure exceeds a given threshold value.

5 A hot and cold water mixing valve according to claim 4 wherein the valve body contains an intermediate chamber, the outlet duct communicates with the intermediate chamber, the valve chamber is cylindrical and is disposed within the intermediate chamber transversely to the inlet and outlet ducts, one end of the cylindrical valve chamber forms the valve chamber outlet and communicates with the intermediate chamber, and a port in a side wall of the valve chamber is open to the inlet duct; the spool extends through the outlet of the valve chamber to a first diaphragm closing the corresponding end of the intermediate chamber; the opposite end of the valve chamber is closed by piston means at the corresponding end of the spool; a projection of the piston means extends beyond the valve chamber into the intermediate chamber and is secured to a second diaphragm closing the corresponding end of the intermediate chamber; and in the first position of the spool, wherein the valve chamber outlet is closed to the outlet duct, the closure is effected by pressure of the first diaphragm against the valve chamber outlet.

6 A hot and cold water mixing valve according to claim 5 wherein the first and second diaphragms and the opposite end faces of the spool have equal effective areas, whereby no net axial force on the spool arises from water pressure within the flow control valve when the spool is in the first position and the flow control valve is closed.

7 A hot and cold water mixing valve according to any one of claims 4 to 6 wherein the cold water inlet of the flow control valve leads to an actuator for the spool.

8 A hot and cold water mixing valve according to claim 7 wherein the actuator comprises diaphragm means having a relatively

large effective area exposed to the pressure of the cold water, and a relatively small effective area exposed to the pressure of water flowing through the flow control valve.

9 A hot and cold water mixing valve according to claim 8 wherein the actuator comprises a relatively large diaphragm exposed to the pressure of the cold water rigidly connected to a relatively small diaphragm exposed to the pressure of water flowing through the flow control valve, and the relatively small diaphragm is rigidly connected to the spool.

10 A thermostatic hot and cold water mixing valve according to any one of the preceding claims.

11 A hot and cold water mixing valve according to any one of the preceding claims wherein the flow control valve is at the hot water inlet to the mixing valve and the cold water supply pressure is sensed by leading cold water at supply pressure to the flow control valve from upstream of the mixing valve.

12 A hot and cold water mixing valve provided with a flow control valve responsive to water pressure in the cold water supply to the mixing valve, substantially as herein described with reference to and as illustrated in either of the accompanying drawings.

15.

**Patents Act 1977**  
**Examiner's report to the Comptroller under Section 17**  
**(The Search report)**

Application number  
**GB 9217945.6**

**Relevant Technical Fields**

(i) UK Cl (Ed.L) F2V (VA5, VA30, VV10, VV13)  
 (ii) Int Cl (Ed.5) F16K, G05D

Search Examiner  
**PAM HYETT**

Date of completion of Search  
**15 OCTOBER 1993**

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-  
 1-12

(ii) ONLINE DATABASE: WPI

**Categories of documents**

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A: Document indicating technological background and/or state of the art.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2201487 A	(CARADON MIRA)	1-3, 11
X	GB 1291723	(MEYNELL VALVES) See particularly page 2, lines 82-89	1, 3, 10, 11
X	EP 0273988 A1	(MIYAWAKI INC) See particularly Figures 2 and 7	1-3, 10, 11

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